JPRS 77024

18 December 1980

USSR Report

PHYSICS AND MATHEMATICS

No. 66

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JPRS 77024

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USSR REPORT

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UDC 534.231:535.211

MOVING LASER THERMOOPTICAL ULTRASONIC SOURCES

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26, No 2, Mar/Apr 80 pp 182-188 manuscript received 31 Jul 79

BOZHKOV, A. I., BUNKIN, F. V., YESIPOV, I. B., MALYAROVSKIY, A. I. and MIKHALEVICH, V. G., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] This article presents a detailed study of the characteristics of a moving thermooptical radiator which produces monochromatic sound waves in liquids. The process of formation of the radiation pattern, influence of movement on the effectiveness of the process of excitation of sound, and limitations on the frequency range resulting from the finite dimensions of the radiator, determined by the area of absorption of light, are studied. A broad range of speeds of movement of the radiator, from subsonic to supersonic, is studied. A theoretical analysis is presented and analytic expressions are derived for the sound pressure in an arbitrary area of the wave. An experimental study is done on the acoustic fields of an emitter with rod configuration moving at a velocity in the range from zero to twice the speed of sound in the liquid. Experimental and theoretical results are in good agreement. Figures 4; references: 8 Russian.
[162-6508]

UDC 534:538

EXPERIMENTAL STUDY OF NONLINEAR INTERACTION OF ULTRASONIC RAYLEIGH WAVES IN A TWO-LAYER SYSTEM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26, No 2, Mar/Apr 80 pp 189-193
manuscript received 2 Apr 79

VIKTOROV, I. A. and TALASHEV, A. A., Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences

[Abstract] An experimental study is presented of an electric output signal which is a specifically defined resultant (convolution) of two input signals. The signal is studied in a system consisting of lithium niobate plus a semiconductor crystal of CdS, paying particular attention to the variation in the amplitude of the signal as a function of the electric conductivity of the crystal with various spectral compositions of light striking the crystal. The experiments were performed with Rayleigh waves propagating over the polished surface of the lithium niobate crystal in contact with the CdS crystal. The convolution signal is found to vary significantly with the spectral composition of the light striking the crystal. The optimum (maximum) values of the attenuation factor α and of the signal do not coincide. The most probable cause of the variation in electron attenuation of ultrasonic surface and body waves as a function of spectral composition of illumination is the development of electron traps of various types with relaxation times of the order of the period of the ultrasonic wave, and regions of increased conductivity arising in the crystal under the influence of the illumination due to the heterogeneity of the photoelectric characteristics of the crystal. Figures 3; references 11: 6 Russian, 5 Western.
[162-6508]

UDC 534.232

THERMOOPTICAL EXCITATION OF ACOUSTIC FIELDS IN A LIQUID BY A PERIODIC SEQUENCE OF LASER PULSES

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26, No 2, Mar/Apr 80 pp 230-236 manuscript received 29 Jun 79

LIMSHEV, M. L., MIKHALEVICH, V. G. and SHIPULOV, G. P., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] This article continues the authors' study of the excitation of acoustic fields in an absorbing liquid by a periodic sequence of laser pulses of nanosecond duration considering the effectiveness of transformation of the optical radiation to acoustical and the diffraction of the acoustical waves in the liquid medium. The possibilities are determined of controlling the spectral composition of the

acoustic field by changing the characteristics of the medium and the parameters of the optical radiation. The variation in the effectiveness of excitation of acoustic fields as a function of temperature is measured in water at low power densities of the stimulating emission. Figures 5; references 15: 12 Russian, 3 Western.
[162-6508]

UDC 534.26

EXCITATION OF LOVE WAVES PROPAGATING OVER A CYLINDRICAL SURFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26, No 2, Mar/Apr 80 pp 237-241 manuscript received 11 Jun 79

PYATAKOV, P. A., Institute of Acoustics imeni N. M. Andreyev, USSR Academy of Sciences

[Abstract] Love waves propagating over a cylindrical surface are studied. It is demonstrated that the distribution of amplitudes of these compressional waves, excited by linear sources, depends significantly on the competing effect of the cover layer and the curvature of the surface, as well as the sign of the difference in velocities of transverse body waves within the material of the layer and the cylinder. If the curvature is sufficiently great, the influence of the layer is slight. Application of a retarding layer to cylinders of sufficiently great radius leads to preferred excitation of the fundamental waves with suppression of waves of higher harmonics. Figures 4; references 16: 12 Russian, 4 Western.
[162-6508]

UDC 534.26

THE NEAR FIELD AND IMPEDANCE OF A RIGID SPHERE VIBRATING PARALLEL TO A FLAT BARRIER

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 26, No 2, Mar/Apr 80 pp 242-247 manuscript received 6 Jul 79

RZHEVKIN, S. N., Moscow State University imeni M. V. Lomonosov, Physics Department, Acoustics Section

[Abstract] A study is made of the sonic field and impedance of a rigid sphere vibrating parallel to a nearby infinite flat (absolutely hard or soft) barrier. The problem is solved by replacing the barrier with the mirror reflection of the sphere in the barrier, the center of which is located at a given distance from the center of the real vibrating sphere. After this, all calculations of sonic fields are

performed as if the two spheres were located in open space. It is found that the change of impedance of the sphere caused by the influence of the scattered wave is much weaker than when oscillations are perpendicular to the surface. An examination is made of the influence that a nearby surface has on formation of the directional pattern of emission. Figure 1; references: 2 Russian.
[162-6508]

UDC 621.365.91

A LOW-ENERGY HIGH-DENSITY NANOSECOND-PULSE ELECTRON BEAM FOR SURFACE HEATING

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 253, No 6, pp 1383-1386 manuscript received 21 May 80

MESYATS, G. A., corresponding member of the USSR Academy of Sciences, PROSKUROVSKIY, D. I., ROTSHTEYN, V. P. and LEBEDEVA, N. I., Institute of High-Current Electronics, Siberian Department of the USSR Academy of Sciences

[Abstract] High-energy nanosecond laser beams are used for surface treatment with extremely high heating and cooling rates. Low-energy (10-20 keV) high-density (1-3 kA/cm^2) electron beams are preferable for controlling physical and chemical changes in surface layers no thicker than 10^{-4} cm of metals (Al, Cu, Fe, Ni, Mo) and semiconductors (Si). Producing such electron beams has been made feasible by using diodes with explosively emitting needle cathodes and flat anodes separated by the smallest possible distance dependent on the voltage and on the power density. The target material can be heated up to its boiling point at rates up to 10^{11} K/s with resulting temperature gradients up to 10^7 K/cm, followed by a slower but still very fast cooling. The feasibility of this process with such a diode was tested experimentally on two materials. Copper foils were annealed, after preliminary vacuum annealing, with a 20 ns - 25 MW/cm^2(peak) 15 keV electron beam and a 50 ns - 50 MW/cm^2 (peak) electron beam for producing a zone of plastic deformation and a zone of melting with corresponding stress relaxation and reduction of microhardness. Silicon single crystals were doped and in the process amorphized by implantation of 150 keV arsenic or phosphorus ions to concentrations ranging from $6\cdot10^{13}$ to $6\cdot10^{15}$ cm^{-2}, then treated with a 50 ns - 20 MW/cm^2(peak) single-pulse electron beam. This treatment was found to cause recrystallization and to impart desirable electrical characteristics to a thin p-n junction. The authors thank L. S. Bushnev for the assistance and the helpful suggestions, also B. S. Azikov and N. G. Moiseyev for the furnishing specimens of doped silicon. Figures 2; references 7: 5 Russian, 2 Western.
[1-2415]

ELECTRICITY AND MAGNETISM

OSCILLATION OF THE SIGN OF FARADAY ROTATION CAUSED BY Eu^{3+} OF IONS IN A SUPERSTRONG MAGNETIC FIELD OF UP TO 11 kT

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31, No 11, 5 Jun 80 pp 659-663 manuscript received 11 Apr 80

PAVLOVSKIY, A. I., DRUZHININ, V. V., TATSENKO, O. M., KOLOKOL'CHIKOV, N. P., BYKOV, A. I. and DOLOTENKO, M. I., Moscow Engineering-Physics Institute

[Abstract] A study is presented of the Faraday effect in organic glass containing Eu^{3+} ions at $4 \cdot 10^{20}$ cm^{-3} on the MK-1 explosively driven magnetic field compression generator, producing pulsed magnetic fields with strengths of up to 11 kT. The fields were measured by means of Faraday effect oscillograms using type TF-5 glass at a wavelength of 632.8 nm. The studies were performed at room temperature. It is found that internal diamagnetism predominates over uncompensated paramagnetism under the experimental conditions used. Figures 2; references 8: 6 Russian, 2 Western.
[161-6508]

UDC 532.529

BUILDUP OF A SHOCK WAVE IN A LIQUID CONTAINING GAS BUBBLES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 253, No 6, pp 1330-1332 manuscript received 15 Apr 80

GASENKO, V. G., NAKORYAKOV, V. Ye. and SHREYBER, I. R., Institute of Thermophysics, Siberian Department of the USSR Academy of Sciences, Novosibirsk

[Abstract] The already experimentally established appearance and buildup of an oscillating shock wave with sharp crests in a liquid containing gas bubbles is here confirmed theoretically on the basis of the approximate Rayleigh equation for a boiling metal. This equation has a dominant nonlinearity of the $(\frac{dR}{dt})^2$ kind (R denoting the bubble radius and t denoting time). The equation of state is derived in the second approximation with respect to $\Delta V/V_0$ (V, V_0 denoting the volume and the initial volume respectively) and together with the equation of motion yields an equation of perturbation of the Boussinesq kind with a nonlinearity due to high compressibility of the mixture. This equation has a solution that describes steady shock waves. Numerical calculations reveal the buildup to a sharp peak when the dimensionless parameter $\delta P_0/2\gamma P_0$ (P_0 denoting the initial pressure and γ denoting the adiabatic exponent) is included. The same equation can be rewritten in a form corresponding to the model of a wave in a fluid with variable viscosity. The article was presented by academician S. S. Kutateladze on 25 Dec 79. Figure 1; references 14: 13 Russian, 1 Western.
[1-2415]

DEVELOPMENT IN LASER TECHNOLOGY

Moscow PRAVDA in Russian 24 Sep 80 p 2

[Article by Academician Ye. Velikhov: "Glass for Lasers"]

[Text] Over the twenty years that have elapsed since the invention of the first ruby laser, optical generators have been developed that operate on a variety of active media: crystals and glasses with ions of chromium and rare-earth elements, liquids, gases. Each is typified by its own field of application. However, only a few lasers have good energy characteristics and high efficiency, primarily those that work on carbon dioxide and on neodymium ions introduced into crystals and glasses. Their emission is in the infrared region of the spectrum, and hence is invisible to the eye.

Lasers that use neodymium glasses have produced record-breaking powers and energies of radiation in the light pulse. Pulse duration may vary from hundredths to billionths of a second or less, and the divergence of the rays in the beam can be reduced to 10 angular seconds. This means that at distances of one kilometer the cross section of the beam increases by no more than 10 centimeters. Thanks to high directionality and intensity of the radiation, glass lasers are widely used in geodesy and radar for exact measurements of angular coordinates and large distances. By focusing such radiation in a small region of space we can create an enormous concentration of energy. A focused laser beam destroys and vaporizes the strongest materials, including diamond and corundum. Graphic examples of the use of these effects in practice are the piercing of calibrated holes in ultrastrong materials such as ruby jewels for watches, microwelding, eye surgery. An important advantage of glass lasers is their relatively low cost, as well as small size.

Until recently, all devices of this kind used silicate glasses, which are based on silicon oxide, or to put it more simply, ordinary sand. However, there has been one singular feature: stimulation of emission

that is highly monochromatic or has narrow divergence is inevitably accompanied by appreciable deterioration of energy characteristics. This defect shows up especially acutely in pulse-periodic lasers, which are of great practical importance. The fact is that the laser characteristics of glasses are determined to a great extent by the microstructure of the near neighborhood of the neodymium ions. This implies that these characteristics can be optimized by proper selection of the glass-forming principles, i. e. by changing the neighborhood of the active ions.

A collective of scientists of a number of institutions of the USSR Academy of Sciences, the State Optics Institute, and also engineers of the optics industry, has made a comprehensive study of different glass-like systems activated by ions of rare-earth and transition metals. Long before similar work had been started elsewhere, Soviet researchers had shown that glasses based on phosphorus compounds have the optimum combination of properties that are important for use in lasers. Experiments done in various laboratories of our nation have shown that devices based on phosphate glasses have a low lasing threshold, i. e. a little energy is sufficient for onset of laser action. At the same time, highly monochromatic emission is achieved without deterioration of energy parameters. The optical distortions that arise in laser operation due to nonuniform heating of the active element are one-tenth of the level in air and gases.

After an in-depth study of the interaction between the composition of glasses and their spectroscopic, optical and physicochemical characteristics, scientists have worked out the physical principles of quantum electronics of glass-like laser media. They have also developed a number of industrial formulas for glasses for different types of lasers, and have introduced new technology for getting highly homogeneous phosphate glasses into series production. The paper "Fundamental Studies of Activated Glass-Like Systems and Development of a New Class of Neodymium Glasses Based on Phosphates" has now been deservedly entered into competition for the State Prize of the USSR.

What are the advantages of the new materials? Model experiments have shown that the use of phosphate-based glasses instead of the traditional silicate formulas gives luminous fluxes of maximum intensity, simplifies the optical system of the facilities, improves reliability and considerably reduces cost.

But phosphate glasses are suitable for more than just powerful lasers. In pulse-periodic facilities they triple or quadruple the average power, multiply emission brightness by ten, and reduce energy consumption by a factor of 1.5-2. Such light generators are widely used in geodesy and technology. The use of phosphate glasses in one type of device alone saves more than a million rubles a year.

Monochromatic emission, high intensity and directionality of the beam produced by lasers based on phosphate glasses make it possible to convert radiation without appreciable losses to shorter wavelengths -- green, blue and ultraviolet, each with its own peculiearities.

Glasses used in lasers must have high mechanical, thermal and chemical stability. In this area, phosphate glasses had been inferior to the silicate varieties since phosphate compounds dissolve readily in water. But on the basis of their research, the authors of the paper have developed phosphate glasses with extraordinarily high chemical resistance. They can withstand tropical humidity and a temperature of about 50°C for years. The authors of the paper have proposed special methods of treating active elements to improve thermal stability.

Research done in close cooperation by academic and sector-wide organizations has been put into extensive practice. The priority of Soviet scientists in this area is defended by dozens of Soviet patents, and by a number of foreign patents. The work as a whole is a clear example of the close relationship between science and practice.
[5-6610]

6610
CSO: 1862

UDC 533.915.03:535.21:537.226:621.378

IONIZATION-THERMAL BREAKDOWN OF AIR NEAR THE SURFACE OF METALS IRRADIATED BY A CO_2 LASER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 253, No 4, 1980 pp 867-871 manuscript received 17 Mar 80

BONDARENKO, A. V., GOLUBEV, V. S., DAN'SHCHIKOV, Ye. V., LEBEDEV, F. V., NASTOYASHCHIY, A. P. and RYAZANOV, A. V., Institute of Atomic Energy imeni I. V. Kurchatov, Moscow

[Abstract] The effect of gas breakdown by optical frequency irradiation was discovered in 1963 and now two mechanisms of breakdown are posited: development of electron avalanche and many-photon ionization. This threshold is much lower than breakdown in a gas. Plasma may form in the gas near the surface of the irradiated target at a temperature less than its evaporation temperature. The process of associative ionization of nitric oxide plays a decisive role in plasma formation. Formation of the plasma jet in laser treatment of materials may greatly alter the thermal equilibrium of the irradiated target. Figures 2; references 13: 9 Russian, 4 Western.
[177-8617]

EFFECT OF SUPPRESSION OF EMISSION ON THE SECOND HARMONIC IN A DISPERSING LASER PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31, No 11, 5 Jun 80 pp 639-642 manuscript received 1 Apr 80

ANDREYEV, N. Ye., ARTSIMOVICH, V. L., KAS'YANOV, Yu. S., KOROBKIN, V. V., SILIN, V. P., SILIN, P. V. and STENCHINKOV, G. L., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Spectral-time studies of scattering from a laser plasma on the fundamental frequency and second harmonic were studied using the radiation of a single-frequency neodymium laser with angle of incidence 90° and 22.5° on an aluminum target. In both cases the duration of radiation on the harmonic was significantly shorter than on the fundamental frequency. The peaks of emission on the harmonic coincided with the minima of the scattered pulses on the fundamental frequency, the envelope of which was approximately the same shape as the laser pulse itself. The intensity of "specular" scattering at frequency 2ω was approximately an order of magnitude greater for P polarization than for S polarization. Time correlation of these scattering peaks was also clearer for P polarization. It was also learned that striction nonlinearity of the plasma under conditions of supersonic flow of matter causes the electric field to fall off as the critical density is approached.

This attenuation of the field is conducive to suppression of emission on the second harmonic in the vicinity of the critical density. Figures 3; references: 2 Russian.
[161-6508]

UDC 621.325

INCREASING THE EFFECTIVENESS OF LASER RADIATION AMPLIFIERS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII Vol 32, No 6, 1980 pp 979-984 manuscript received 2 Aug 79

DIVIN, D. G., IVANUSHKINA, L. V., KOROLEV, V. I. and SEDOV, B. M.

[Abstract] Estimates are presented of the maximum efficiencies of laser amplifiers made of neodymium glass which can be achieved by increasing the energy density of the radiation being amplified to the maximum possible level. A computer study was done on amplification of both parallel and diverging beams at several levels of excitation of the active medium with various distributions of inversion through the length of the active element. The analysis was based on solution of an equation describing propagation of emission with amplification in a medium with inverse population. The resultant relations show how the energy density in the beam of amplified emission depends on distance traveled by the light in the active medium. Amplifiers working with two and three energy levels are considered. Designs of active elements are proposed in which the energy density of the amplified emission is increased to the level that determines volumetric breakdown of the medium. A multistage diverging-beam amplifier consisting of active elements in the shape of segments of a spherical arc is studied. The designs suggested can increase amplifier efficiency by 30 to 40%. Figures 3; references 12: 9 Russian, 3 Western.
[172-6508]

UDC 621.378.331.8

GAIN AND SATURATION PARAMETER OF A WAVEGUIDE CO_2 LASER

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII Vol 32, No 6, 1980 pp 985-991 manuscript received 11 Jul 79

DORONIN, V. G., NOVIKOV, V. I. and STEPANOV, V. A.

[Abstract] A study is made of the unsaturated gain and saturation parameter of a waveguide CO_2 laser. Results of calculations are compared with experimental data. The calculation method used considers diffusion of excited molecules to the walls of the small-diameter tube and the equilibrium nature of distribution of the population of CO_2 molecules at the lower laser level in a mixture of CO_2 plus nitrogen and helium. The radial distribution of gain and saturation parameter are calculated as a function of discharge current and gas pressure. Above a certain optimal level of current, which varies inversely with pressure, the gain increases only in the area of the gas near the wall, decreasing near the center of the tube. The saturation parameter does not show a similar peak. Figures 4; references 18: 12 Russian, 6 Western.
[172-6508]

UDC 621.378.5

GENERATION OF A TRAIN OF SUBNANOSECOND PULSES IN A SOLID-STATE LASER WITH A SATURABLE ABSORBER IN A SECOND RESONATOR

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII Vol 32, No 6, 1980 pp 992-997 manuscript received 27 Apr 79

MILINKEVICH, A. V.

[Abstract] It is theoretically shown in a space-time approach that a train of short pulses (10^{-9} - 10^{-10} s) can be obtained in solid-state lasers with rapid active Q switching, and also in lasers with passive switching, achieving reproducibility of the time pattern of radiation of near 100%. Placing a Kerr cell in a supplementary cavity resonator transforms the system to a lasing mode intermediate between the giant-pulse and picosecond-pulse modes. Numerical integration of differential-difference equations yields relations that show how the duration and contrast of emission pulses depend on laser parameters. The laser system can produce both smooth giant pulses and pulses modulated at the intermode beat frequency, the depth of modulation increasing with a decrease in initial transmission of the Kerr cell and coefficient of reflection of the additional mirror. Figures 3; references 11: 10 Russian, 1 Western.
[172-6508]

UDC 621.378.5

AUTOMATIC CONTROL AND DISPLAY OF WAVELENGTH OF RADIATION OF A TUNABLE DYE LASER

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 32, No 6, 1980 pp 998-1001
manuscript received 27 Aug 79

PERCHI, Z. I. and TARNAY, A. A.

[Abstract] An automatic system is suggested for control and display of the wavelength of radiation of a multiple-cell tunable dye laser with a dispersing resonator element consisting of a diffraction grating operating at high orders, thus assuring relatively uniform distribution of the intensity of radiation. The diffraction grating is rotated by a stepper motor via a sine potentiometer that makes emission wavelength a linear function of shaft-angle position. The motor is automatically positioned relative to reference point determined by automatic search after the system is switched on. An arithmetic unit solves the linear equation for wavelength dependence on shaft-angle position. The result is displayed in digital form as the wavelength in angstrom units, and is also used to control the laser system. The operation of the system is programmed by code switches. Pumping is by a pulsed molecular nitrogen laser. A block diagram of the automatic control and display system for laser wavelength is presented. Figure 1; references 5: 4 Russian, 1 Western.
[172-6508]

UDC 621.375.8

DEPENDENCE OF THE ENERGY CHARACTERISTICS OF A DYE LASER ON THE METHOD OF FIRING THE PUMPING TUBES

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 32, No 4, Apr 80 pp 602-606
manuscript received 19 Jun 79

BASOV, Yu. G., MIKHALINA, T. I., NIKIPOROV, V. G. and SOPIN, A. I.

[Abstract] A study of a dye laser has been made to determine how its energy characteristics depend on the method of firing the pumping tubes. A standard solution of $3 \cdot 10^{-4}$ mole/liter rhodamine 6G was passed at the rate of 2.5 liters/min through a cylindrical quartz tube inside a cylindrical shield made of quartz and coated with duffusely reflecting amorphous silicon dioxide. The active medium was pumped by an INP2-5/75A xenon tube, initial pressure 50 mm Hg. The optical resonator cavity consisted of two plane dielectric mirrors with reflection coefficients 0.995 and 0.50, respectively, at the rhodamine 6G wavelength and quartz windows with a slant angle equal to the Brewster angle. The pump source was fired either with a keep-alive arc or without it by self-breakdown. A keep-alive arc has been found to improve the energy characteristics of emission. The emission pulse was 1.5 times higher in amplitude with much shorter risetime and no second current peak. With a

keep-alive arc there are no energy losses on shock waves in the plasma, the gas is heated more efficiently and the plasma is thermalized faster, also the conditions of evaporation at the hot tube shell are improved. The discharge resistance is increased and the amplitude of the second current peak is reduced by better matching of the load with the discharge circuit. Also a shorter pumping pulse only slightly above the threshold level is required. The performance parameters of a dye laser have been found to depend largely on the quality of the pump tube manufacture. The authors thank A. V. Reymers for assistance. Figures 3; references 10: 6 Russian, 4 Western.
[164-2415]

HOW THE NEUTRINO WAS WEIGHED

Moscow SOVETSKAYA ROSSIYA in Russian 3 Jun 80 p 4

[Article by A. Malinov, candidate of technical sciences: "HOW 'THEY WEIGHED' THE NEUTRINO"]

[Text] Today, the GID correspondent for Sovetskaya Rossiya writes about an outstanding discovery by a group of Soviet physicists--V. A. Lyubimov, E. G. Novikov, V. Z. Nozik, Ye. F. Tret'yakov and V. S. Kozik. The neutrino has been discovered to have a rest mass!

This discovery even stands out among such spectacular developments of recent years as the discovery of new types of elementary particles, proof of the quark structure of matter, detection of the mysterious quasistellar and quasigalactic objects in the universe. It stands out because it leads to a reconsideration of many notions concerning the structure of the universe as a whole. The point is that among the hundreds of types of elementary particles known to science, only four of these particles--protons, electrons, photons and neutrinos--are stable, while the remaining particles are short-lived and decay into stable particles almost immediately after they are created. It is due to their stability that protons, electrons, and photons play an exceptional role in nature: they make up (together with neutrinos) all the observed matter in the universe. Figuratively speaking, the longevity of the universe is due to the longevity of these particles. Neutrinos are also long-lived particles, and for this reason, it is natural to expect that their role in the universe is also exceptional. However, neutrinos not only do not enter into the composition of matter, but they also interact very weakly with matter, so that until recently their purpose in nature was completely incomprehensible. The discovery of rest mass for neutrinos immediately transforms these particles into the most important elementary particles in the universe.

According to generally accepted ideas, our universe was formed as a result of an explosion of a superdense cluster of primeval matter and has been expanding for approximately 15 billion years. During the process of expansion, the primeval matter underwent a series of transformations, as a result of which ordinary matter that makes up the stars and galaxies was formed, while all of space was filled with free electromagnetic radiation and a uniform neutrino gas. Experimental measurements of the expansion rate of the universe shows, on the one hand, that our universe is closed and has the form of a three-dimensional sphere. On the other hand, measurements of the average energy density of matter in the universe have shown that there is not enough matter to form a closed universe. Until recently, this paradox in cosmology could not be resolved.

The neutrino gas in the universe is very dense. There are about 500 particles per cubic centimeter. If the neutrinos are massless, then even at such a density they contribute very little to the average energy density of matter and have practically no effect on the geometry of the universe. Now, neutrinos have been discovered to have a mass equal approximately to 1/20,000 of the mass of the electron. But even such a small mass multiplied by the high density of the neutrino gas leads to the fact that the total energy of the neutrino gas in the universe is 100 times greater than the energy of all the remaining particles taken together and is enough to close the universe. This completely resolves the paradox that until now did not allow describing the geometry of the universe uniquely. Thus, our universe can be represented as an expanding three-dimensional sphere, filled with a neutrino gas, which completely describes the spatial structure of the universe. Galaxies, formed from protons, electrons and photons, are interspersed in this neutrino gas and do not effect anything.

It is now clear that neutrinos determine the fate of the universe!

The neutrino not only determines the geometry of the universe as a whole, but it is also responsible for the existence of galaxies. Until now, galactic physics had its own problem: the calculation of galactic masses as a sum of the mass of the stars that make up galaxies gave a value that is less than the mass required for the galaxies to be gravitationally stable. Nevertheless, galaxies do not decay into stars. Physicists began to suspect that a large quantity of some kind of matter, which holds the galaxy together with its gravitational field, is hidden within galaxies. Now, with the discovery of the neutrino rest mass, it is clear what kind of matter is hidden in galaxies.

Together with all the encouraging prospects, there also arise completely new problems. These primarily concern cosmology. Answers are hidden deep within matter and the vacuum, and the only path to these answers is through careful, precise experiments, a brilliant example of which is the work carried out by V. A. Lyubimov and his colleagues.
[163-9638]

9638
CSO: 1862

VARIATION OF ENERGY LIFETIME OF A PLASMA AS A FUNCTION OF COLUMN ELLIPTICITY IN THE T-8 INSTALLATION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31, No 11, 5 Jun 80 pp 663-668 manuscript received 12 Apr 80

DOBROKHOTOV, Ye. I., PETROV, D. P., SOLNTSEV, A. M., STEFANOVSKIY, A. M. and SHCHERBAK, A. F., Institute of Nuclear Energy imeni I. V. Kurchatov

[Abstract] Results are presented from measurement of τ_E on the T-8 tokamak for plasma densities $\bar{n}_e = (1\text{-}3)\cdot 10^{13}$ cm^{-3} with a variation in column ellipticity $K=b_z/a_R$ from 1.3 to 1.6. A diagram of the cross section of the tokamak is presented. The method of laser scattering was used to measure the temperature of electrons on the axis of the plasma in several operating modes. A change in the magnetic configuration upon transition from the initial status to a compressed or stretched plasma is accompanied by a very small (a few percent) change in the magnetic field on the surface of the copper cover where the measurement probes are located. This requires a high degree of stabilization of experimental conditions to achieve reproducible results. The value of τ_E is found to be proportional to K^2. Figures 3; references 7: 3 Russian, 4 Western.
[161-6508]

UDC 535.375

FOUR-WAVE INTERACTION AS A CONTROLLABLE FREQUENCY FILTER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 251, No 1, 1980 pp 70-74 manuscript received 26 Oct 79

BLASHCHUK, V. N., PILIPETSKIY, N. F. and SHKUNOV, V. V., Institute of Problems of Mechanics, USSR Academy of Sciences, Moscow

[Abstract] The process of wavefront reversal with degenerate four-wave interaction has selective properties with respect to the frequency of the reversed signal. If opposed reference waves have the same frequency ω_0, then signal reflection is effective for frequencies between $\omega_0 - \delta$ and $\omega_0 + \delta$, where δ is determined by the width of spatial synchronism $\delta \sim \pi c/nL$, n is the refractive index of the medium, L is the length of nonlinear interaction and c is the speed of light, or by the quantity τ_{ch} (the characteristic time of the nonlinearity): $\delta \sim 1/\tau_{ch}$. In some practical applications, the reversing system may be required to selectively reflect a signal with frequency shifted by Ω relative to ω_0. Such selection can be realized if the reflectivity R of the signal to be reversed depends on the frequency ω_s of this signal in such a way that the reflection is maximum with displacement Ω relative to ω_0. In this paper the authors show that such a system with controllable frequency characteristics can be synthesized on the basis of nearly degenerate four-wave interaction. The authors thank Ya. B. Zel'dovich for suggesting this research, and also B. Ya. Zel'dovich for constructive discussions. Figures 4; references 9: 3 Russian, 6 Western.
[178-6610]

UDC 539.194

DRIFT OF MOLECULES SUBJECTED TO RESONANT INFRARED RADIATION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 251, No 1, 1980 pp 74-78 manuscript received 22 Oct 79

DYKHNE, A. M. and STAROSTIN, A. N.

[Abstract] It has been theoretically predicted that macroscopic fluxes of atoms with or against the luminous flux should arise under the action of a traveling resonant wave. These fluxes arise only in the presence of a foreign buffer gas that moves contrary to the resonant particles, so that there is no overall flux of matter. It is shown in this paper that when certain conditions are met, the drift rate of resonant molecules in an infrared field may reach values comparable with their thermal velocity. An investigation is made of the stability of fluxes of resonant particles, and a two-fluid hydrodynamic theory is proposed that describes internal fluxes in a gas mixture. The authors thank L. A. Bol'shov, Ye. P. Velikhov, A. P. Napartovich, V. D. Pis'mennyy and G. I. Surdutovich for interest in the work and useful discussions. References 9: 7 Russian, 2 Western.
[178-6610]

UDC 533.17

NONUNIFORMITY OF THE PHYSICAL CHARACTERISTICS OF ULTRADISPERSED PARTICLES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 251, No 1, 1980 pp 79-81 manuscript received 24 Oct 79

MOROKHOV, I. D., TRUSOV, L. I., LAPOVOK, V. N., PETRUNIN, V. F., IVANOV, A. S., DUBROVINA, A. I. and GANELIN, V. Ya., Moscow Institute of Steel and Alloys

[Abstract] Ultradispersed media, i.e., systems of a large number of particles with dimensions of the order of 10 nm, are a specific type of the condensed state of matter. Various size effects arise in such media when particle size is commensurate with the distances typical of certain physical processes. For particles of this size, there can be no division into "surface" and "volume" effects, and surface changes involve the lattice, structural and electronic subsystems of the particles. In this paper, the authors consider the structural, phase and concentration inhomogeneity of ultradispersed particles. The regular change of interatomic spacing with distance from the center to the surface of a particle is analytically examined within the framework of the model of a continuous medium. It is shown that the contribution to density on the part of the surface layer decreases fairly rapidly with distance from the surface toward the center. Concentration profiles depend on the sorbing properties of the components and their surface activity. Concentration uniformity is unstable in ultradispersed media, and decay may be either by a phase transition of the first kind or by spinodal mechanisms, resulting in concentration "layering" or phase inhomogeneity. Figures 2; references 7: 6 Russian, 1 Western.
[178-6610]

UDC 621.384.8

A MASS SPECTROMETER FOR STUDY OF FAST PROCESSES IN THE GASEOUS PHASE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 253, No 6, pp 1380-1383 manuscript received 4 Apr 80

GRISHIN, V. D., DODONOV, A. F., KUDROV, B. V., LEYPUNSKIY, I. O., SEMENOV, S. Yu., TAL'ROZE, V. L., corresponding member of the USSR Academy of Sciences, and SHAFRONOVSKIY, E. A., Institute of Chemical Physics, USSR Academy of Sciences, Moscow

[Abstract] A mass spectrometer with ion(electron)-optical conversion has been developed for study of fast processes in the gaseous phase and for identification of atoms as well as free radicals by the method of "soft" ionization, for which existing transit-time mass spectrometers with a 10^{-5} s scan are inadequate. It features high speed (10^{-4} s) limited by dispersal of particles and depending on the glow time of the phosphor, high sensitivity, high resolution (150 amu at the 10% level), wide range of simultaneously measurable masses (20-400 amu), and distortionless transfer of the analyzed substance, by means of an inert carrier gas, from the reactor to the ionization zone. The instrument consists of a mixer, a reactor where a chemical process is initiated by some pulse action, a magnetic analyzer with an ion(electron)-optical converter, a photomultiplier, and three oscilloscopes. Experimental measurements were made with it involving photolysis of iodine vapor in an argon atmosphere. A high concentration of particles in the beam passing through the ionization zone was achieved by using an enclosure and a separator of appropriate geometrical configurations for the gasdynamic molecular beam. Figures 2; references 14: 6 Russian, 8 Western.
[1-2415]

FLUCTUATIONS IN THE PHASE OF A STOKES WAVE WITH INDUCED SCATTERING OF LIGHT

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 31, No 11, 5 Jun 80 pp 685-689 manuscript received 6 May 80

BASOV, N. G., ZUBAREV, I. G., MIRONOV, A. B., MIKHAYLOV, S. I. and OKULOV, A. Yu., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Direct observations were made of the fluctuations of the phase of Stokes radiation with induced Mandelstam-Brillouin scattering. A new method was developed for direct measurement of the characteristic phase cutoff time in the Stokes wave in order to allow investigation of the structure of the scattered light lines with monochromatic pumping. The method is based on the idea of use of a two-beam Michelson interferometer. A schematic diagram of the installation is presented. The exciting radiation from a single-frequency YAG laser is split by a half-silvered mirror into two beams that are reflected from independent mirrors with wave reversal which assures ideal adjustment of the interferometer, even for spatially heterogeneous

pumping beams. The results indicate that with induced scattering at the Stokes frequency it is impossible to reproduce the spectrum of the monochromatic exciting radiation in media with a short phase cutoff time. The width of the spectrum of the Stokes component is determined by an equation that describes the constriction of the spectrum of the scattered radiation in the amplification line. The weak feedback allows the Mandelstam-Brillouin induced scattering threshold to be decreased and the effectiveness of reflection to be increased while retaining the reversal properties of the mirror. Figures 3; references 6: 4 Russian, 2 Western. [161-6508]

UDC 537.533.001

OPTOELECTRONIC CELL UTILIZING THERMALLY CONTROLLED SCATTERING OF LIGHT IN A 'POROUS GLASS--LIQUID CRYSTAL' HETEROGENEOUS SYSTEM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 253, No 3, 1980 pp 598-600 manuscript received 17 Mar 80

ALIYEV, F. M., BAUSHEV, V. N., DUL'NEV, G. N., MESHKOVSKIY, I. K. and PROKHOROV, A. M., academician, Leningrad Institute of Precision Mechanics and Optics, USSR Academy of Sciences Physics Institute imeni P. N. Lebedev, Moscow

[Abstract] The results are given of an attempt to create a flat cell to serve as an element of a unit for displaying information on a large screen and capable of operating under conditions of bright external illumination. The container to be filled with the liquid crystal was a plate of porous glass approximately 1 mm thick. The pore occupied about 40 percent of the volume of the entire sample and the average diameter of pores was 3000 to 4000 Å, with the pore distributed with a close to chaotic orientation. The transmission of light by the original porous glass was not greater than 0.5 percent with an incident light wavelength of 550 nm. This was due to the intense scattering of light caused by the strong three-dimensional optical inhomogeneity of the original sample. Fabrication of the "porous glass--liquid crystal" cell amounted only to filling the pores with an appropriate liquid crystal. A study was made of the dependence of light transmission on temperature by means of an SF-26 spectrometer in the visible wavelength region. The temperature of samples was measured by means of a Chromel-Alumel thermocouple with a margin of error of not greater than $\pm 0.5^{\circ}$C. The measurement results show the cell to be characterized by three states: At temperatures below the "solid crystal → liquid crystal" transition point, t_1, the cell practically does not transmit light, with a transmission coefficient of T = 0.5 percent. The transmission coefficient remains constant up to t_1 and above it increases by an order of magnitude. The cell is in the second state after the material filling the pores passes into the liquid crystal phase. This state is similar to that observed in cells of the sandwich type functioning under conditions of dynamic scattering of light. With a further increase in the temperature of the cell the optical anisotropy of the liquid crystal inside the pores is reduced, the scattering of light is reduced, and consequently the transmission coefficient increases. At temperatures higher than the "liquid crystal → isotropic liquid" transition point, t_2, the optical anisotropy of the material filling the pores becomes equal to zero but the refractive index of the isotropic liquid differs considerably from that of the glass and the transmission coefficient does not reach its maximum value. With a further increase in temperature the refractive indices of the isotropic liquid and porous glass are made equal and the

transmission coefficient increases, approaching its maximum value. A comparison of the transmission of light through the cell in state I (that of minimum transmission) and III (maximum transmission) shows that the contrast radio equals 150 : 1. The cell is suited for use in the transmission mode at any temperature higher than t_2. A flat information display device based on a "porous glass--liquid crystal" heterogeneous system can have a practically unbounded surface and has sufficiently high contrast in terms of both transillumination and reflection with ordinary lighting. This unit can be used to produce halftone images. Figure 1; references 10: 4 Russian, 6 Western.
[2-8831]

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